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*(Courtesy Indiana Limestone Co.)*

## FROM WHENCE COMES THE STONE . . . THE QUARRY

Limestone — Quarry developments — Milling operations —Transportation — Laying the finished product — All for the "nation's building stone."

# THE LIMESTONE INDUSTRY

## By KEN BECKER, '38

### PART ONE

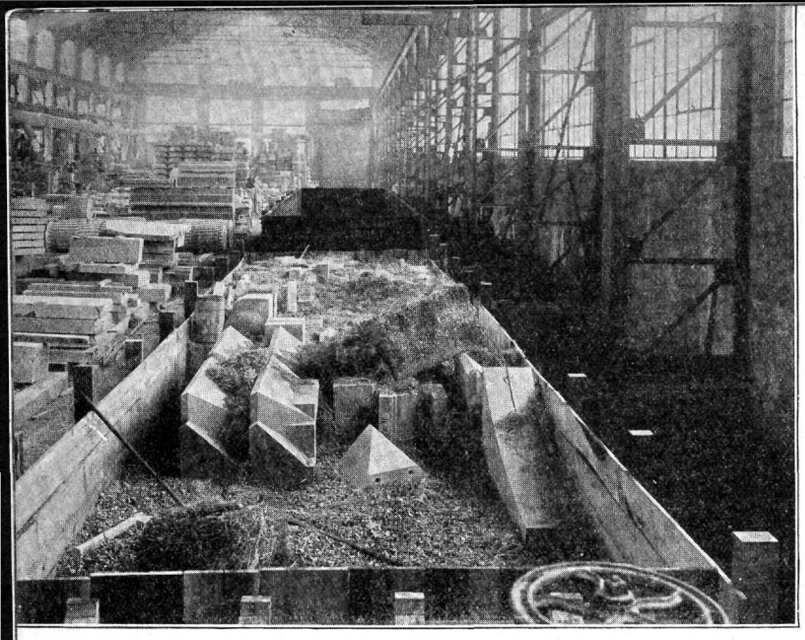
THE limestone industry, which was founded on the daily needs of the civilized world, is an industry in which honest and economical operation is required to make success possible. Although the industry was founded on the daily needs of the civilized world, the fabrication of limestone does not seem to be well-known to the people of the present generation. They have not been familiarized with the usefulness of the stone. The importance of limestone is but half realized and comparatively few people know it by name, although a great proportion of all kinds of buildings in the United States and Europe are constructed of limestone. But those people who have seen the Pyramids, the Gothic cathedrals, Westminster Abbey, St. Paul's Cathedral, and the Houses of Parliament, will have paid their aesthetic respects to the excellencies of limestone. All these structures of the old world were built by using crude and costly methods in fabricating the rough slabs of stone. All the buildings constructed in this modern era are built by using speedy and economical methods in producing the stone.

Limestone, one of the nation's building stones, is fabricated by three essential operations: organizing a quarry, obtaining the rough stone from the quarry, and milling the rough slabs into the finished product.

The preliminary work in organizing a quarry consists in securing suitable quarry land and removing the "overburden." To select suitable quarry land, it is very important to know the geology of salable limestone land. The limestone industry is carried on in various parts of the nation; consequently, the quarry should be located in the most convenient limestone belt. The location of the land is essentially important both from a geological and economical standpoint. Geologically, the quarry land should be located in a prominent limestone belt; economically, the quarry land should be located in or near a railroad center. By analysis, statistics show that the following states produce limestone, in the order of the importance of the industry: Pennsylvania, Indiana, New York, Michigan, Ohio, Illinois, and Missouri. The factors to consider when choosing the location of the quarry in any of these limestone areas are the value of the stone in the beds, the quantity of stone that can be quarried, the number of quarries already located in that vicinity, the standard wages offered by existing quarry operators, the source of electrical power, and the freight rates. With these factors in mind, the prospective quarry owner is able to determine the physical properties and formation of the different sections of the land. The formation of the limestone deposits in the majority of these states is called Jurassie or Oolitic limestone because it is composed of many egg-like bodies. Jurassic limestone is the most common form of limestone, but the formation exists in hundreds of different types of stone, each type being an important building material in itself. Geologists have proved that in the Jurassic Age, all present limestone producing centers were the bed of an ocean. The ocean at that time contained hundreds of different shell bearing animalculae. These sea animals were supposed to have died by the hundreds of thousands of millions and their shells formed a massive bed of carbonate on the sea floor. The limestone in each section of the United States shows an excellent variation in physical properties as degree of crystallization, texture, grain size, grain shape, nature of cementation, brittleness, toughness, or hardness. When seen in the field, limestone is often recognizable by the nature of the outcropping. A true characteristic of pure limestone where the outcropping occurs in large quantities is the presence of bare rocky ground. This is especially noticeable in the mountainous districts where the stone yields only a thin layer of soil covered with stubble grass. All these properties not only have more or less influence on the method of quarrying and quarrying costs, but they also influence the nature of the finished limestone. After the history of a piece of quarry land is determined by geologists, the purchaser applies for an option on the land. Within a specified time, the prospective purchaser is privileged by the owner to investigate all the properties of the land and to determine the value of it.

If an option on a piece of land can be secured, it is usually held for a period of three months. During the time that the option is held, the nature of the land can be determined by making close observation of the physical properties and by the use of a "core-drill." The physical properties are noted by observations on the outcropping of the stone in the fields. Pure limestone is often recognizable by the method of weathering and, if the stone is pure, the bits of outcropping have smooth round surfaces and deep narrow runnels cut out by the rain. In most all limestone districts the waters tend to be hard because of the abundand carbonate of lime dissolved in the frequently occurring underground water pools.

In the last operation to determine the nature of the stone, a core-drill is used to obtain a sample of the grade of stone on the land. A core-drill is a piece of apparatus equipped with a gasoline engine and fitted on the side with a revolving wheel on which is fastened a long hollow piston arm. This hollow piston arm which works up and down as the wheel revolves is fitted on the end with a diamond studded bit. The bit drills into the strata of stone and forms the "core." The core which is a long cylindrical piece of rock varying in length from sixty to eighty feet shows in a graphical way the nature of the strata. After the core-drill operations have been performed on a piece of land, the bed is analyzed by removing the hollow piston arm and forcing the cores of stone out of the chamber into



**BLOCKING THE FINISHED STONE** *(Courtesy Indiana Limestone Co.)*

an open box. Then a permanent report of the strata, the physical properties, and the texture is recorded. The usefulness of a core-drill cannot be over-emphasized; because, by the use of one the real nature of the stone is found. In 1850, when core-drills were not generally known, companies bought most quarry land without the least knowledge of its being good stone land. Now, with conditions as they are, the purchaser is able to take an option on a piece of land, to core-drill for stone and to determine the character of the strata.

After the land has been drilled and stone has been found on it, a practical plan must be formed to develop the resource. To formulate an economical working plan the depth of the overburden, the dip of the beds, and the drainage conditions must be carefully considered. The relation between these factors and the working plan develops along the lines of observation. When the first observations are taken, the conditions which pertain to the overburden, the dip of the beds and the drainage should be noted. The overburden or the material which is stripped consists of a mantle of loose earth, beds of shale, inferior limestones, and other hard rock. In some quarries, the stripping consists in removing a very light mantle of dirt and shale, whereas in other quarries the stripping consists in removing almost as much shale and inferior limestone as there is pure limestone in the bed. Of course the latter operation is more costly and is avoided whenever possible. The dip of the beds and the drainage conditions are important only from a geographical standpoint.

There are many factors involved in the plan of good quarry development. A good quarry, if run successfully, is operated on an efficient and systematic working plan which includes all the important factors of quarry development. The chief factors involved in the plan are the thickness of the limestone beds, topography of the region, depth of the overburden, availability of area for the disposal of waste, the position of the beds, whether flat or tilted, and the strength and soundness of the rock.

The first factor which deals with the thickness of the limestone beds is a general but important factor. In general, in order to insure a profitable operation of the quarry, an available tonnage should be proved that would keep the beds producing for at least twenty years. This estimate of the time of existence for a bed is very general, because some quarries which have been opened in some sections have not completed one year's work on account of the beds being shallow. Sometimes the depth of the beds can be determined by the nature of the outcropping. Some outcrops are very deceiving when viewed in the open field; consequently, considerable study of the formation is necessary in order to determine the true nature of the beds by this method. The best method of determining the thickness of the limestone beds is to core-drill the land. If the land is core-drilled in numerous places and good samples of the strata are obtained, the thickness of the beds can be estimated accurately.

The second factor in the plan is to obtain a minute and detailed description of the region. This description must include the type of surface and the position of streams, rivers, roads, and railroads. The type of surface is one of the most important items to consider in the plan of development. The drainage conditions on the surface must be adequate enough to carry the water, from rain and seepage, away from the cut stone. A good system of drains can be worked out even when the physical properties do not include some natural systems.

The depth of the overburden is also one of the most important factors in the quarry plan. In open surface quarrying, the overburden is a constant problem to the quarry operator. In the underground mining there is no overburden, for the stone is mined and not quarried. The depth of the shale and inferior limestone varies from place to place, while the type of overburden is very much the same in any locality. For example, the overburden on the limestone beds in Indiana, Ohio, and Michigan is very deep, but the overburden on the beds in Texas, California, and Alabama is very small. After the depth of the overburden is estimated, the next problem is the availability of area for the disposal of the waste. Irrespective of the amount of waste that has to be removed, disposal of the overburden is a serious problem. Some quarries are so situated that no dumping grounds are available. If the area is small the waste will have to be transported to some other place and this transportation causes a delay in further operations. If the quarry is located so that there is available land for dumping, the waste is thrown up into huge stacks which are usually called grout piles.

The position of the beds, whether flat or tilted, and the strength and soundness of the rock are factors in the quarry plan which must be considered just before the overburden is removed. The position of the beds can be fixed by examining the length of each formation in the core. In some formations the strata appears flat, but in other deposits the strata is tilted. A flat formation is more desirable than a tilted one, when it comes to setting up the quarry machinery. Of course, the strength and soundness of the rock depend upon the formation of the beds.

*(To be concluded next issue)*